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PROCEEDINGS

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FREEZE DRYING PEACHES

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EVALUATION OF PEACHES FOR PROCESSING

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In the Department of Horticulture and Forestry at Rutgers a genetic bank of several hundred varieties and selections of peaches and nectarines have been developed which are suitable for cultivation in the Eastern United States.

Because this large selection of raw material was available, the Department of Food Science, in cooperation with the Department of Horticulture and Forestry and the U. S. Department of Agriculture, initiated a project to select newly developed varieties of peaches suitable for commercial processing and to determine, if possible, the influence of chemical and physical properties of the fresh fruit on processing quality. The latter objective was initiated with the peach breeder in mind. Since a breeder must make important judgments on a very limited number of fruit early in a breeding program, a positive correlation of some factor or factors, measured objectively, with processing quality could be an important tool for him.

The project has been in existence for the past 3 years. To date we have conducted analyses on fresh peaches (with both freestone and nonmelting clingstone) and nectarines for possible correlation with processed quality. A total of 61 clingstone peach, 46 freestone peach, and 25 nectarine selections or varieties were evaluated for processing potential. Analyses conducted were as follows:

> pH total acidity, soluble solids, texture (shear-press), color (Gardner Color-Difference Meter), color (Color Dictionary), carotene (provitamin A), ascorbic acid.

Fruit were then canned and frozen. These same analyses, except for the vitamins, were also conducted 5 days after canning. Four to 6 months after canning or freezing the samples were again analyzed as per the raw fruit schedule. In addition, sensory evaluation was conducted to determine flavor difference, flavor preference, and texture preference of the test sample versus one of known high quality.

The canning procedure was as close to a commercial operation as facilities allowed, which was briefly as follows: Sort and wash, halve and pit, lye peel (2 percent NaOH), tank wash, spray wash, steam heat, fill (constant weight) into No. 2 peach cans, add hot syrup, seal, process at 212° F. for 25 minutes, cool, and store.

Perhaps the most significant departure from a commercial procedure was the sugar concentration used in the syrup. Early in our work our flavor panelists complained of "excessive" sweetness which hampered their ability to detect real flavor differences, so we reduced the syrup from 40 to 35 percent sugar.

The freezing procedure was modified from the standard industrial procedure primarily to accommodate ascorbic acid analysis. Briefly, the procedure was as follows: Wash and sort, halve and pit, lye peel (2 percent NaOH), tank wash, spray wash, hand slice, fill into No. 2 peach cans, add previously boiled and cooled syrup, pull vacuum (15 in.), seal, and blast freeze at -15 F. This procedure was very satisfactory, producing a product with no significant amount of browning, even though no ascorbate was added as is usual in commercial practice.

The varieties and selections processed were selected by the Department of Horticulture and Forestry. Fruit was picked approximately 3 days before they were fully tree ripe. Fruit was ripened to the desired stage at 70° F. prior to analysis and processing.

Varieties showing the greatest promise in a given year were processed after two different picking dates the following year for a comparison of picking condition effect. In this case picking times were approximately 3 days and 7 days prior to being fully tree ripe.

As indicated earlier, ideally, the analyses of the fresh fruit would enable us to predict the canned or frozen fruit quality. In practice, however, this has not been possible, using the procedures followed in our laboratory.

Ultimately, the flavor panel evaluation has been the single most important criterion for evaluating quality, although other values, such as color, pH, soluble solids, and vitamin content, definitely play a role in the overall product quality. We have not given up this search as yet. As you can imagine, we have accumulated a mass of data in the past 3 years on this project. In our search for meaningful correlations between the fresh and processed fruit, simple correlation coefficients were calculated using an IBM 7040 Computor.

From the data gathered to date, however, it does appear that we can predict from the raw fruit analyses the processed value (not overall quality) of a number of these quality factors. Correlation analyses of fresh versus canned and fresh versus frozen analytical data were significant at the 5 percent level or less for several factors studied relative to itself, e.g. pH of fresh versus pH of canned product.

Very few raw fruit analyses could reliably be used to predict the value of a different analyzed quality factor after processing. Two notable exceptions to this were fresh pH versus processed total acidity (and vice versa) and fresh ascorbate content versus processed carotene content.

The former is to be expected since pH is a function of total acidity. The latter, however, was somewhat surprising, especially since it held true only for the clingstone peaches tested and not for the freestones. (Very high correlation for clingstones--some correlation for freestones.)

Vitamin C content of our fresh samples showed a number of varieties to contain two to three times the average values found in the literature. Literature values show 7 to 8 mg./100 g., and some of our test samples showed up to 25 mg./100 g. While our canned fruit had 2 to 3 mg./100 g. higher than those reported in the literature, the frozen samples were considerably lower in vitamin C content than that reported. Our samples gave smaller values after freezing and storage by as much as 50 percent, while the literature indicates an increase in vitamin C after freezing and storage.

Provitamin A or carotene content of our fresh samples varied considerably with several samples having an unusually high content. Frozen samples after storage had carotene concentrations generally comparable to the fresh, while canned samples generally showed a marked increase in carotene content. This phenomena has been reported for some vegetables in the literature by other workers, but they give no explanation for it. One explanation we are experimenting with now is that the change in carotene concentration is a function of a change in product tissue mass or density which occurs after processing, due to the osmotic pressure set up outside the tissue.

No correlation could be made between the panel texture preference ratings and those obtained with the shear-press. Differences in firmness of peaches, however, such as the unusual firmness of the frozen clings after thawing were clearly indicated by shear-press readings.

The influence of picking time (3 days versus 7 days) varied considerably from one variety to another, but was consistent for a given variety. The peaches picked 7 days prior to being fully ripe generally produced a canned product equal to or slightly poorer, in flavor and/or texture than its 3-day counterpart. Differences were slightly more noticeable in the frozen product.

The most promising processing varieties selected are presented in tables 1, 2, and 3 for clingstones, freestones, and nectarines, respectively, Also listed are a few varieties which, although they are not very promising as commercial processing stock, do have other attributes of special interest.

Nonmelting Clingstone Peaches

The nonmelting clingstone peach varieties have been used almost exclusively for canning by industry. Thus, the test varieties and selections of nonmelting clingstones have been considered in this light (table 1). However, two selections, 554291 and 561997, were quite good in both flavor and texture as a frozen product. This is not meant to suggest that they would be acceptable as a frozen product at the present, but certainly does indicate that a clingstone frozen pack might be developed. Further, it is suggested that, with proper selection of clingstone varieties and freezing methods, the clingstone frozen pack could be superior to frozen freestones for two reasons. First, when frozen clingstones are thawed for use, many of the selections were much less subject to enzymatic browning. Note: No ascorbic acid was added to either frozen pack. Second, because of the firmness of clingstone peaches, they do not become mushy and lose their desirable texture.

The overall high quality of the Babygold series of nonmelting clingstone peaches was indicated in the first year's results from this project. This information was accepted enthusiastically by several commercial processors and a whole new industry has been initiated in eastern North America--over 2 million trees of the Babygold varieties have been planted.

In western Michigan and in the Shenandoah Valley of Virginia, they are to be canned as halves. In southern Ontario, Arkansas, and the Carolinas, they will be used for puree at present.

The Babygold 5-9 series gives a relatively long harvest and processing season (3-1/2 weeks), and it is felt that this season will be lengthened by the possible addition of Babygolds 2, 3, and 4. For this purpose some of the early ripening NJC selections are being considered because of their close quality similarity to the already named Babygolds.

Ambergem, the only clingstone previously grown in the East, competes directly with Babygold 6 but was judged to have slightly poorer flavor and texture. In addition, the excessive red at the pit area can cause a processing problem.

Dixon 1, a new California variety, was judged to be in the quality range of Babygold 8 and 9 but it is not well adapted to growing conditions in the East.

While our tests indicated that the selection NJC 22 was slightly poorer in flavor than the Babygolds, it was included in the table primarily because of the interest shown by the Raw Products Research Committee of the National Canners Association. It was considered a good quality canned peach and competes directly with Babygold 6 and Ambergem in season of ripening.

Selection 540467 was included in the table due to its unusually high contents of vitamin C and provitamin A (relative to other samples by the method used) and because of its good horticultural characters as well.

The only peach judged better in canned flavor than the Babygolds by the flavor panel was the selection 561994 A. This selection was also judged superior by the Raw Products Committee. The unusual nutlike flavor, however, was so different that it must be considered a "specialty type" rather than a commercial "prototype" for the present.

Freestone Peaches

Superior processing quality would make a new freestone variety more versatile and, therefore, likely to be more widely planted. With a perceptible trend and a real concern throughout the eastern peach-growing industry for the utilization of more and more freestones for processing, it is important to recognize superior processing qualities in

Table 1.--Horticultural and processing characteristics of certain nonmelting clingstone varieties and selections

Variety or selection	Weeks ripe from Elberta	Size (in.)	Flesh color 1/	Red at pit 2/	Remarks 3/
NJC 70	-5-1/2	2-1/4-1/2	YO	0	Earliest ripening; slightly poorer quality but similar to Babygolds.
NJC 72	-4-1/2	2-1/2	YO	0	Earliest clingstone comparable to Babygolds.
NJC 74	-4	2-1/2	YO	0	Not quite as good as Babygolds 5, 6, and 7.
540467	-3-1/2	2-1/2	Y	0	Clear yellow flesh and skin; quality poorer than Babygolds but high vitamin C and provitamin A content.
NJC 75	-3-1/2	2-1/2	Y	0	Not quite as good as Babygolds 5, 6, and 7.
Babygold 5	-2-1/2	2-1/2-3/4	Y	1-	Very good quality.
554291	-2-1/2	2-3/8	OY	0	Fresh fruit crisp; frozen flavor and texture better than Babygolds, browns quite rapidly.
561997	-2-1/2	2-3/8	O	0	Orange flesh; frozen flavor and texture better than Babygolds.
562021	-2-1/2	2-3/8-1/2	YO	0	Comparable to Babygolds.
NJC 11	-2-1/2	2-1/2	Y	1-	Comparable to Babygolds.
NJC 78	-2	2-1/2	Y	0	Comparable to Babygolds; clear yellow skin.
Babygold 6	-2	2-1/2-3/4	Y	1-	Very good quality.
561994 A	-2	2-1/2	YO	0	The only clingstone judged better in flavor than Babygolds.
Ambergem	-2	2-1/2-3/4	Y	2	Only cling previously grown in N. E. America; not quite as good flavor as Babygolds; red pit problem.
NJC 22	-2	2-1/4-3/4	Y	1-	Similar to Babygolds.
Babygold 7	-1	2-1/2-3/4	Y	1-	Very good quality; small pit.
Dixon 1	-1/2	2-1/2	Y	0	In quality range of Babygolds 8 and 9.
Babygold 8	0	2-1/2	Y	1-	Good quality, similar to Babygold 5, 6, and 7.
Babygold 9	+1	2-1/2-3/4	Y	1-	Good quality, similar to Babygold 5, 6, and 7.
571963	+1	2-1/2-3/4	YO	1-	Very firm fresh fruit; comparable to Babygolds in processed quality.

1/ Y = yellow; O = orange.
2/ O = clear; 1 = slight; 2 = mush.
3/ Except where noted, processed quality remarks refer to canned quality.

new varieties. This is also important in evaluation of the selections that are available for parents for the development of the varieties of the future.

Several widely grown varieties were found to produce a satisfactory product, either heat processed or frozen (table 2). However, only a few of the new freestones were found to be equal to or better than the high quality variety Sunhigh, which was considered the standard for quality.

Table 2. --Horticultural and processing characteristics of certain freestone varieties and selections

Variety or selection	Weeks ripe from Elberta	Size (in.)	Flesh color [1]	Processing potential	Remarks
NJ 202	-5-1/2	2-1/2	Y	Canned	Freestone when fully ripe; good for very early ripening.
Redhaven	-4	2-1/2	Y	Canned and frozen	Present standard for early ripening freestones.
NJ 208	-3	2-3/8-1/2	Y	Frozen	Better quality than Sunhigh.
Sunhigh	-2-1/2	2-1/2-3/4	Y	Canned and frozen	Standard of fresh quality; standard of excellence for canned and frozen samples.
Redqueen	-2	2-1/2	Y	Canned and frozen	Hardy; very new variety; slightly better flavor than Sunhigh canned; better flavor than Sunhigh frozen.
Summercrest	-1	2-1/2-3/4	Y	Frozen and canned	Outside remains greenish until fully ripe, thus not attractive as fresh fruit; very good frozen quality.
Blake	-1/2	2-3/4-3	Y	Canned and frozen	Firm; excessively red at pit; poorer quality than Sunhigh; lye peeling difficult.
Redskin	0	2-1/2-3/4	Y	Frozen	Firm; green "coat" after lye peeling--not after freezing.
Elberta	0	2-1/2-3/4	Y	Canned and frozen	Dull; old standard; poorer than Sunhigh.
Jerseyqueen	0	2-3/4	Y	Canned and frozen	Firm; very good new variety.
Honey Dew Hale	+1/2	2-3/4	W	Frozen and canned	Firm enough to process well; unique flavor; makes attractive frozen product; browns quite rapidly.

1/ Y = yellow; W = white.

NJ 202 was found to produce a good quality product when heat processed, unusually good for such an early ripening peach. It could only be considered to be a freestone, however, when it was fully ripe. NJ 208 was found to be better quality frozen than Sunhigh.

These tests confirmed earlier experience that, while unattractive as a fresh fruit, Summercrest is very good frozen. A new variety, Redskin, was also found to be good for freezing. Two very recently named varieties from the New Jersey Peach Breeding Project, Redqueen and Jerseyqueen, seemed to be promising for both freezing and heat processing.

On the basis of the evaluation of Honey Dew Hale, a white-fleshed sport of J. H. Hale, it seems likely that a firm white-fleshed peach could make a very attractive and desirable processed product.

Nectarines

Of the numerous nectarine varieties and selections tested for processing potential, few demonstrated any promise based on our data (table 3). Two problems were common to most samples: (1) Difficulty in pitting owing to their soft-flesh texture and frequently the lack of a free pit, and (2) a tendency to take on an unattractive greenish-yellow color after heat processing.

The soft-texture problem was further complicated by the somewhat fibrous nature of the flesh of most samples such that, after peeling and spray washing as well as after

Table 3. --Horticultural and processing characteristics of certain nectarine varieties and selections

Variety or selection	Weeks ripe from Elberta	Size (in.)	Flesh color [1/]	Processing potential	Remarks
551025	-5	2-1/2-3/4	Y	Canned	Rated comparable in quality to Sunhigh.
550893	-5	2-1/2-5/8	Y	Canned	Rated comparable in quality to Sunhigh.
Merrill Princess	-4-1/2	2-1/4-3/8	Y	Canned	Semifreestone; difficult to pit.
Nectared 7	-1	2-1/2-5/8	Y		
Nectared 8	0	2-3/8-1/2	Y	Frozen	Slightly better than Nectared 7.
Nectalate	+1-1/2	2-1/2-5/8	W	Frozen	Better flavor and texture than Nectared 7; very soft; difficult to peel.

1/ Y = yellow; W = white.

canning, these samples had a ragged appearance. This was reflected in the relatively high shear-press texture data of the canned products.

The latter problem has been noted by other workers with peaches grown with high nitrogen fertilization. It is believed that, in the case at hand, the fertilization was not principally responsible, but rather, that it was a varietal characteristic. Although they were considered much better than most of the nectarine varieties, the Merrill Princess, Nectared 7, Nectared 8, and Nectalate (table 3) were all subject to this problem to some extent.

The above-named varieties were all tested in 1962, using Nectared 7 as the reference sample. In 1963 and 1964 freestone peaches were used as the reference, because it was felt that for a processed nectarine to be acceptable, it must be of a quality comparable to a product known to be acceptable to the public.

The 1963 test samples, whether canned or frozen, generally did not compare favorably with the freestone standard of quality in flavor or texture, and again the greening was evident.

In 1964 a "breakthrough" was observed in the testing of selections 551025 and 550893. Although both selections were rated poorer in the flavor of the frozen product, both the flavor and texture of these samples when canned were rated comparable to the high quality freestone peach, Sunhigh. In addition, the color of these samples was fully acceptable, and no greening effect was observed.

This suggests that nectarine varieties can be developed which are suitable for heat processing and which can offer the public a new and pleasant canned dessert fruit.

Conclusions and Summary

A total of 61 clingstone peaches, 46 freestone peaches, and 25 nectarine varieties and/or selections have been evaluated for commercial canning and freezing potential. Of these, many of the new clingstone selections from the New Jersey breeding program were selected as having processing potential based on their chemical, physical, organoleptic, horticultural, and processing characteristics. Two nectarine selections, two freestone peach selections, and two newly named freestone peach varieties were identified as having processing qualities (canning and/or freezing) comparable to or better than the best varieties now being used for processing.

Frozen processing via vacuum packing in metal cans was found to produce a highly desirable frozen product without added ascorbate for prevention of browning.

Ascorbic acid (vitamin C) content of numerous fresh and heat-processed samples were higher than literature values for this vitamin.

Provitamin A content of the test samples determined chromatographically as β-carotene, was significantly lower than the literature values for fresh peaches. The frozen and canned products did not have the high processing losses as reported in the literature. The implications of these findings have been discussed.

Correlation analyses indicated that the processed value of a number of objective factors of the canned and frozen fruit can be predicted from the fresh fruit analysis. These included pH, total acidity, ascorbic acid, and β-carotene. In the case of texture the fresh analysis was highly correlated only with the frozen product texture value--not with the canned texture value.

In some instances, the analysis conducted 5 days after canning was a good indicator of the analysis after 6 months' storage of the canned product. Included in this group was pH, total acidity, and soluble solids.

Fresh ascorbate content had a high correlation with processed β-carotene content, but most interactions between objective analysis were too variable for definitive evaluation.

Correlation between objective analyses and sensory evaluation data were also subject to excessive variation.

Thus, while certain objective quality factors of the processed fruit can be predicted on the basis of the analysis of the fresh fruit and/or on the basis of the analysis 5 days after canning, it has not been possible to predict total canned or frozen fruit quality on the basis of objective analysis(es) of the fresh fruit.

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DISCUSSION

Question: I'd like to ask Dr. Harris three questions about the pasteurized peach slices. What was the retail price of the 28-ounce size? What was the time in the pasteurizer, and what was the maximum price for that?

Dr. Harris: The time in the pasteurizer varied. I'd say around 4 minutes was adequate. We adjusted to reach a temperature of 160° F. in the center of the jar. Incidentally, I believe you will find this information in the mimeograph report.

Regarding the price on the product used in the market test, first let me say that the test was made with the 16-ounce jar. Dr. Miller experimented with different prices. He concluded that 35 cents, I believe, would be a good price for that particular pack. He did use different prices in his studies. Does that answer the question?

Question: What is the main purpose for refrigerating the product? Is it mainly to retard this matter of activity, since it seems to me with the chemicals you add, it would actually activate the bacteria. So it is mainly an addition of enzymatic activity that we are trying to achieve.

Mr. Heaton: It is for two reasons. First, the peach slices are protected from microbial spoilage by refrigeration to allow the preservative time to penetrate into the slices. The second is to retard ripening and other enzymatic activity.

Question: Dr. Harris, you mentioned 1 minute and 40 seconds, I believe, on this sterilization.

Dr. Harris: I made the statement that we had been able in experimental tests to obtain an essentially sterile product with as low as 1 minute and 40 seconds.

Question: At what temperature were you working?

Dr. Harris: One minute and 40 seconds in steam at 212°, with a jar rotating at 50 r. p. m. The required time would vary with the pack. One that is a little overripe would require more time than one in which there is considerable firmness in the slices. I wish to repeat that we don't recommend that short a pasteurization period. We are thinking in terms of around 4 minutes in steam at 212° F., with the jar rotating at 50 r.p.m.

Question: Dr. Hoover, have you ever tried your freeze drying technique on dried syrup processed peaches?

Dr. Hoover: Yes, we have. We found that we have some problems with peaches. But the main thing is the freezing temperature where syrup is used.

Questioner: I am speaking of peaches that have been dipped in syrup, you know, then drained and put through your process.

Dr. Hoover: Yes, we have done that.

Question: What was the technique, Dr. Hoover, that you used in impregnating peaches? Dr. DiMarco mentioned it.

Dr. Hoover: Yes, I developed a continuous vacuum impregnator. I have been working with a commercial company in the operation of this unit. We have 1 year of experience in working with apples. I have done some in the lab with peaches. It is also a blancher, if anybody would be interested in that phase.

It is a continuous unit. It can eliminate a lot of labor and we think that it has quite a potential.